
Contents

Preface	xv
Acknowledgments	xvii

Part 1 Airport Planning

1 The Nature of Civil Aviation and Airports	3
Introduction	3
Commercial Service Aviation	4
Passenger Air Carriers	7
International Air Transportation	7
Air Cargo	8
General Aviation	10
Civil Aviation Airports	11
Historical Review of the Legislative Role in Aviation	17
Air Commerce Act of 1926	17
Civil Aeronautics Act of 1938	18
Federal Airport Act of 1946	21
Federal Aviation Act of 1958	24
Creation of the U.S. Department of Transportation	26
Airport and Airway Development Act of 1970	27
Airline Deregulation Act of 1978	31
Impact of Airline Deregulation	32
The Airport and Airway Improvement Act of 1982	33
The Aviation Safety and Capacity Act of 1990	33
AIR-21: The Wendell Ford Aviation Investment Act for the 21st Century	34
The Aviation and Transportation Security Act of 2001	34
Vision 100 Century of Aviation Act of 2003	35
NextGen Financing Reform Act of 2007/ FAA Reauthorization Act of 2009	35
State Roles in Aviation and Airports	36

Aviation Organizations and Their Functions	37
Federal Agencies of the United States	
Government	37
Federal Aviation Administration	37
Transportation Security Administration	42
Environmental Protection Agency	42
National Transportation Safety Board	43
State Agencies	43
The International Civil Aviation	
Organization	44
Industry and Trade Organizations	45
References	46
Web References	47
 2 Aircraft Characteristics Related	
to Airport Design	49
Dimensional Standards	57
Landing Gear Configurations	59
Aircraft Weight	61
Engine Types	63
Atmospheric Conditions Affecting	
Aircraft Performance	69
Air Pressure and Temperature	70
Wind Speed and Direction	73
Aircraft Performance Characteristics	75
Aircraft Speed	75
Payload and Range	77
Runway Performance	79
Declared Distances	82
Wingtip Vortices	89
References	90
 3 Air Traffic Management	95
Introduction	95
A Brief History of Air Traffic Management	96
The Organizational Hierarchy of Air Traffic	
Management in the United States	97
The Air Traffic Control System	
Command Center	97
Air Route Traffic Control Centers	97
Terminal Approach Control Facilities	98
Airport Traffic Control Tower	99
Flight Service Stations	100
Air Traffic Management Rules	100

Airspace Classifications and Airways	101
Airways	106
Colored Airways	107
Victor Airways	108
Jet Routes	108
Area Navigation	108
Air Traffic Separation Rules	110
Vertical Separation in the Airspace	111
Assigned Flight Altitudes	111
Longitudinal Separation in the Airspace ...	111
Lateral Separation in the Airspace	113
Navigational Aids	114
Ground-Based Systems	114
Satellite-Based Systems: Global Positioning System	124
The Modernization of Air Traffic Management	127
NextGen	129
SWIM	129
NextGen Data Communications	130
NextGen Enabled Weather	130
References	130
 4 Airport Planning Studies	 133
Introduction	133
Types of Studies	135
The Airport System Plan	135
Airport Site Selection	137
The Airport Master Plan	138
The Airport Project Plan	141
Continuing Planning Process	146
References	147
 5 Forecasting for Airport Planning	 149
Introduction	149
Levels of Forecasting	151
Forecasting Methods	152
Time Series Method	154
Market Share Method	156
Econometric Modeling	158
Forecasting Requirements and Applications	162
The Airport System Plan	164
The Airport Master Plan	164
The Future Aviation Forecasting Environment	168
References	169

Part 2 Airport Design

6 Geometric Design of the Airfield	173
Airport Design Standards	173
Airport Classification	174
Utility Airports	176
Transport Airports	177
Runways	177
Runway Configurations	177
Single Runway	178
Parallel Runways	178
Intersecting Runways	181
Open-V Runways	181
Combinations of Runway Configurations	181
Runway Orientation	183
The Wind Rose	186
Estimating Runway Length	191
Runway System Geometric Specifications	201
Parallel Runway System Spacing	205
Sight Distance and Longitudinal Profile	207
Transverse Gradient	213
Airfield Separation Requirements	
Related to Runways	213
Obstacle Clearance Requirements	213
FAR Part 77	216
ICAO Annex 14	221
TERPS	222
Runway End Siting Requirements	223
Taxiways and Taxilanes	228
Widths and Slopes	228
Taxiway and Taxilane Separation	
Requirements	229
Sight Distance and Longitudinal Profile	234
Exit Taxiway Geometry	234
Location of Exit Taxiways	238
Design of Taxiway Curves	
and Intersections	244
End-Around Taxiways	249
Aprons	250
Holding Aprons	250
Terminal Aprons and Ramps	252
Terminal Apron Surface Gradients	254
Control Tower Visibility Requirements	254
References	255

7	Structural Design of Airport Pavements	257
	Introduction	257
	Soil Investigation and Evaluation	259
	The CBR Test	263
	The Plate Bearing Test	263
	Young's Modulus (<i>E</i> Value)	266
	Effect of Frost on Soil Strength	266
	Subgrade Stabilization	267
	FAA Pavement Design Methods	268
	Equivalent Aircraft Method	269
	Cumulative Damage Failure Method	270
	Design of Flexible Pavements	271
	CBR Method	272
	Layered Elastic Design	273
	Design of Rigid Pavements	275
	Westergaard's Analysis	275
	Finite Element Theory	276
	Joints and Joint Spacing	277
	Continuously Reinforced Concrete Pavements	279
	Design of Overlay Pavements	282
	Pavements for Light Aircraft	286
	Pavement Evaluation and Pavement	
	Management Systems	287
	References	288
8	Airport Lighting, Marking, and Signage	291
	Introduction	291
	The Requirements for Visual Aids	292
	The Airport Beacon	293
	Obstruction Lighting	293
	The Aircraft Landing Operation	293
	Alignment Guidance	294
	Height Information	294
	Approach Lighting	296
	System Configurations	296
	Visual Approach Slope Aids	301
	Visual Approach Slope Indicator	301
	Precision Approach Path Indicator	302
	Threshold Lighting	303
	Runway Lighting	303
	Runway Edge Lights	304
	Runway Centerline and Touchdown	
	Zone Lights	304
	Runway End Identifier Lights	309

Taxiway Lighting	310
Taxiway Edge Lights	311
Runway Guard Lights	313
Runway Stop Bar	314
Runway and Taxiway Marking	315
Runways	315
Runway Designators	315
Runway Threshold Markings	320
Centerline Markings	320
Aiming Points	320
Touchdown Zone Markings	321
Side Stripes	321
Displaced Threshold Markings	321
Blast Pad Markings	322
Taxiway Markings	323
Centerline and Edge Markings	323
Taxiway Hold Markings	325
Taxiway Shoulders	326
Enhanced Taxiway Markings	328
Closed Runway and Taxiway Markings	328
Airfield Signage	329
Runway Distance Remaining Signs	330
Taxiway Guidance Sign System	331
Taxiway Designations	331
Types of Taxiway Signs	333
Signing Conventions	337
Sign Size and Location	338
Sign Operation	340
References	341
9 Airport Drainage	343
Purpose of Drainage	343
Design Storm for Surface Runoff	343
Determining the Intensity-Duration	
Pattern for the Design Storm	344
Determining the Amount of Runoff by	
the FAA Procedure	347
Determining the Amount of Runoff by	
the Corps of Engineers Procedure	358
Layout of Surface Drainage	368
References	380
10 Planning and Design of the Terminal Area	383
Introduction	383
The Passenger Terminal System	383
Components of the System	383

Design Considerations	387
Terminal Demand Parameters	393
Facility Classification	394
Overall Space Approximations	396
Level of Service Criteria	397
The Terminal Planning Process	399
Space Programming	400
Other Areas	415
Overall Space Requirements	416
Concept Development	416
Horizontal Distribution Concepts	417
Vertical Distribution Concepts	423
Schematic Design	426
Analysis Methods	427
Design Development	441
The Apron Gate System	442
Number of Gates	442
Ramp Charts	448
Gate Size	453
Aircraft Parking Type	455
Apron Layout	456
Apron Circulation	457
Passenger Conveyance to Aircraft	457
Apron Utility Requirements	458
References	461

Part 3 Special Topics in Airport Planning and Design

11 Airport Security Planning	467
Introduction	467
History of Airport Security	468
Airport Security Program	470
Security at Commercial Service Airports	472
Passenger Screening	473
Baggage Screening	475
Employee Identification	476
Perimeter Security	477
Vulnerability Assessment	477
Security at General Aviation Airports	481
Future Security	481
References	482
12 Airport Airside Capacity and Delay	483
Introduction	483
Capacity and Delay Defined	484
Capacity and Delay in Airfield Planning ...	485

Approaches to the Analysis of Capacity and Delay	486
Factors That Affect Airfield Capacity	489
Formulation of Runway Capacity through	
Mathematical Theory	490
Mathematical Formulation of Delay	490
Formulation of Runway Capacity through	
the Time-Space Concept	492
Formulation of Ultimate Capacity	497
Mathematical Formulation of	
Ultimate Capacity	497
Application of Techniques for Ultimate	
Hourly Capacity	514
Parameters Required for Runway	
Capacity	514
Computation of Delay on Runway Systems	520
Graphical Methods for Approximating	
Delay	525
Application of Techniques for Annual	
Service Volume	532
Simulation Models	537
Gate Capacity	538
Analytical Models for Gate Capacity	539
References	541
13 Finance Strategies for Airport Planning	543
Introduction	543
Background	543
Federal Funding Programs in the United States	544
The Airport Development Aid	
Program	547
The Passenger Facility Charge	
Program	556
State and Local Participation in Financing	
Airport Improvements	557
Bond Financing	558
General Obligation Bonds	558
General Airport Revenue Bonds	559
Special Facility Bonds	559
PFC Bonds	560
CFC Bonds	560
Privatization of Airports	560
Financial Planning	562
Rate Setting	564
Evaluation of the Financial Plan	571
References	571

14 Environmental Planning	573
Introduction	573
Policy Considerations	574
Pollution Factors	576
Air Quality	576
Water Quality	577
Aircraft and Airport Noise	579
Sound Pressure and Sound Pressure Level	580
Aircraft Noise Effects and Land-Use	
Compatibility	592
Determining the Extent of the Problem	598
Finding Solutions	604
Noise Regulations	609
Construction Impacts	615
Social Factors	616
Land Development	616
Displacement and Relocation	617
Parks, Recreational Areas, Historical Places,	
Archeological Resources,	
and Natural and Scenic Beauty	617
Consistency with Local Planning	618
Ecological Factors	619
Wildlife, Waterfowl, Flora, Fauna,	
Endangered Species	619
Wetlands and Coastal Zones	619
Flood Hazards	620
Engineering and Economic Factors	620
Costs of Construction and Operation	620
Economic Benefits and Fiscal Requirements	624
Energy and Natural Resources	624
Summary	625
References	625
15 Heliports	629
Introduction	629
Heliports	629
The Nature of Helicopter Transportation	629
Characteristics of Helicopters	630
Factors Related to Heliport Site Selection	631
References	648
Index	651